First Pass at RPC Readout using 400 u strips and GEM Controller with TCPU, etc

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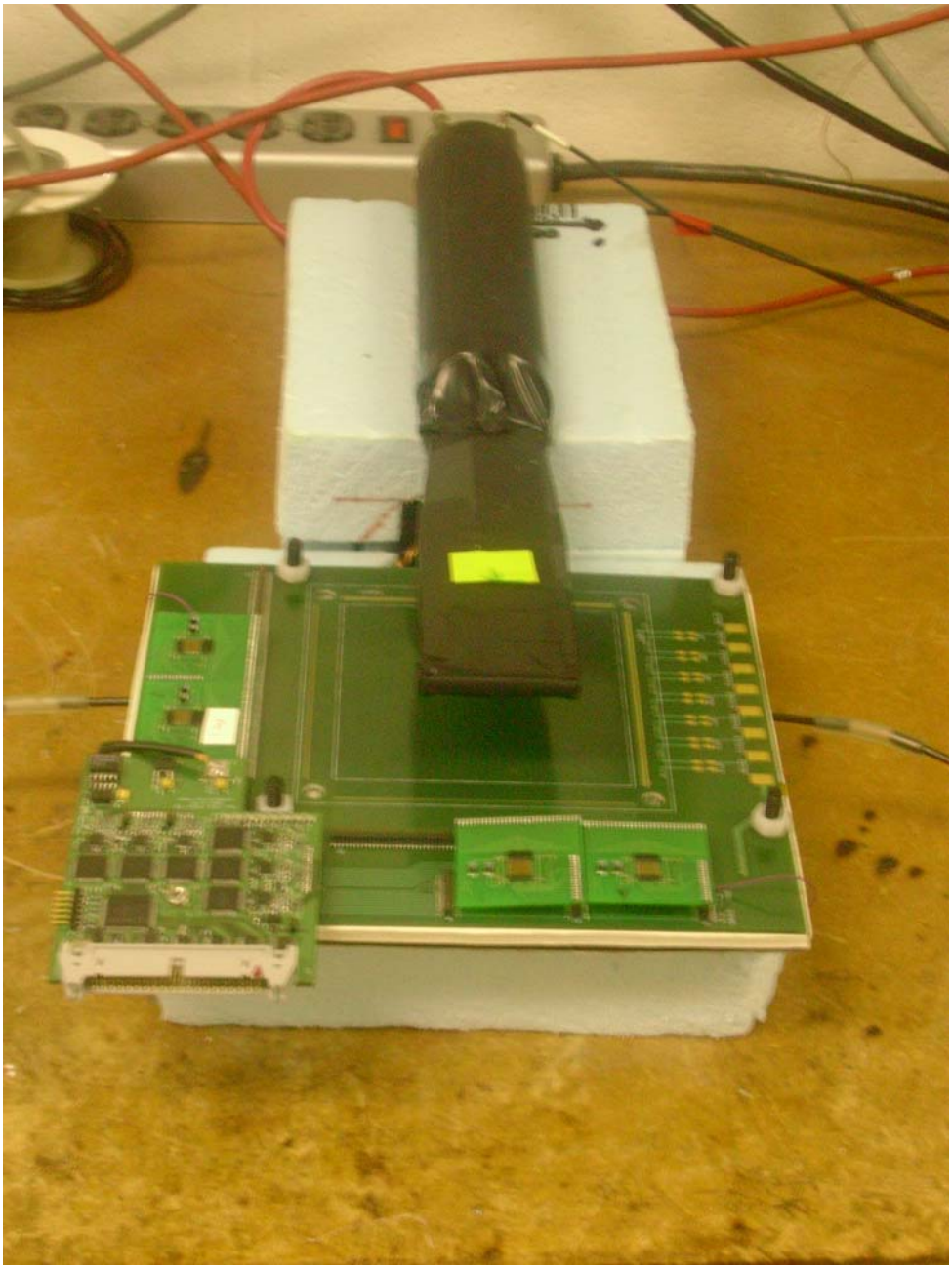
We have built a small RPC, Resistive Plate Chamber, specifically to test a system which is being built to test GEM, Electron Multiplier, Tracking chambers.

The Readout uses an X-Y grid of strips on 400 micron centers, with the back set of strips exposed between the front strips. The front-end of the readout is done with APV25 chips having 128 channels of analog amplifier and analog buffer (192 long) each.

This test is very crude and at an early stage. The purpose of documenting it now is to aid further progress.

The readout was done by setting the APV25 chips to single sample mode. The TCPU was programmed to provide a delay after the real cosmic until the trigger to the APV chip, simulating trigger latency in STAR. The APV 25 latency parameter was then scanned. This scanning was done by running the I2C setup and DAQ with different parameters inside a bash script, looping on values of the latency. Single sample mode was used.



Evidence for real signals:

1) Peaks of roughly 20 channels wide are seen in the APV chips where they would be expected to be seen with the cosmic ray trigger scintillator coverage used.

2) Signals are seen in every other set of 2 channels to the APV, matching the connection to the strips.

3) Signals are seen at roughly an appropriate latency setting of the APV chip, and not seen with larger settings which would correspond to times before the cosmic ray. (seen at 0x36 to 0x40 clock latency, not seen at 0x55)

4) There is evidence of opposite polarity signals adjacent to the peaks seen, and we have observed this behavior previously with a very different readout system.

Problems:

1) Only 2 of a possible 6 APV chips were positioned in a way to see signals. (Our setup only has 4 chips)

2) The matching of RPC high voltage to signal levels appropriate to the APV25 may not be optimum. Many of the signals saturate the APV.
(The RPC gives a range of signal heights in avalanche mode, typically a factor of 10)

3) The result is based on terrible statistics.- 5 events per data run – primarily due to the offline analysis software still being under development. There are 50 good events in each run of 100 triggers due to another problem.

4) We do not have pedestal values, and the pedestals may be different in each event, or this may be an illusion due to charging up of unconnected channels. Better analysis software is needed.

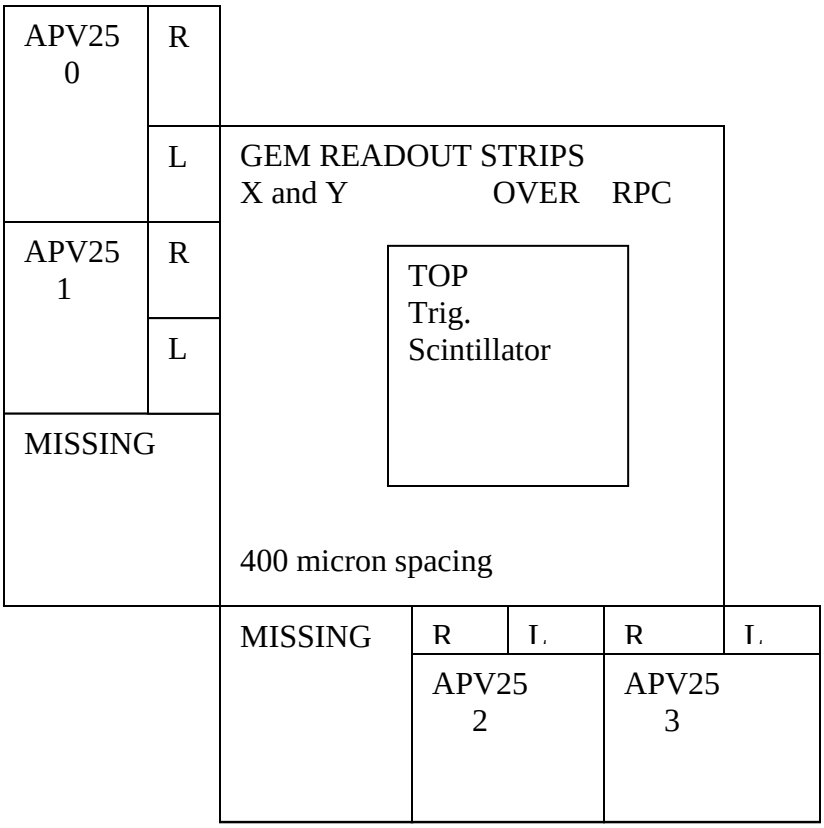
5) Many strange signals are seen in the portions of APV chips not connected to strips. This may be a charge-up phenomenon.

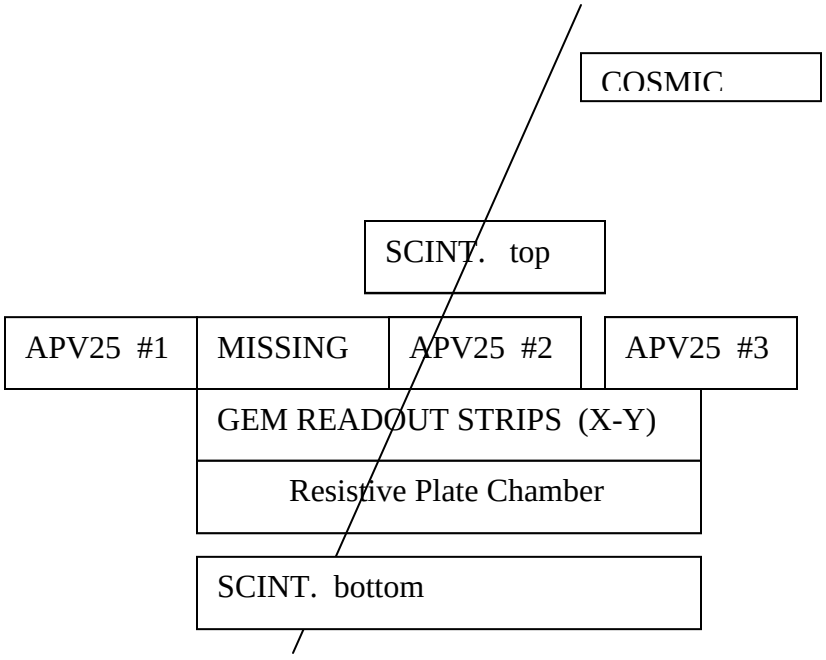
6) We have not yet gotten the APV25 calibration charge injection to work.

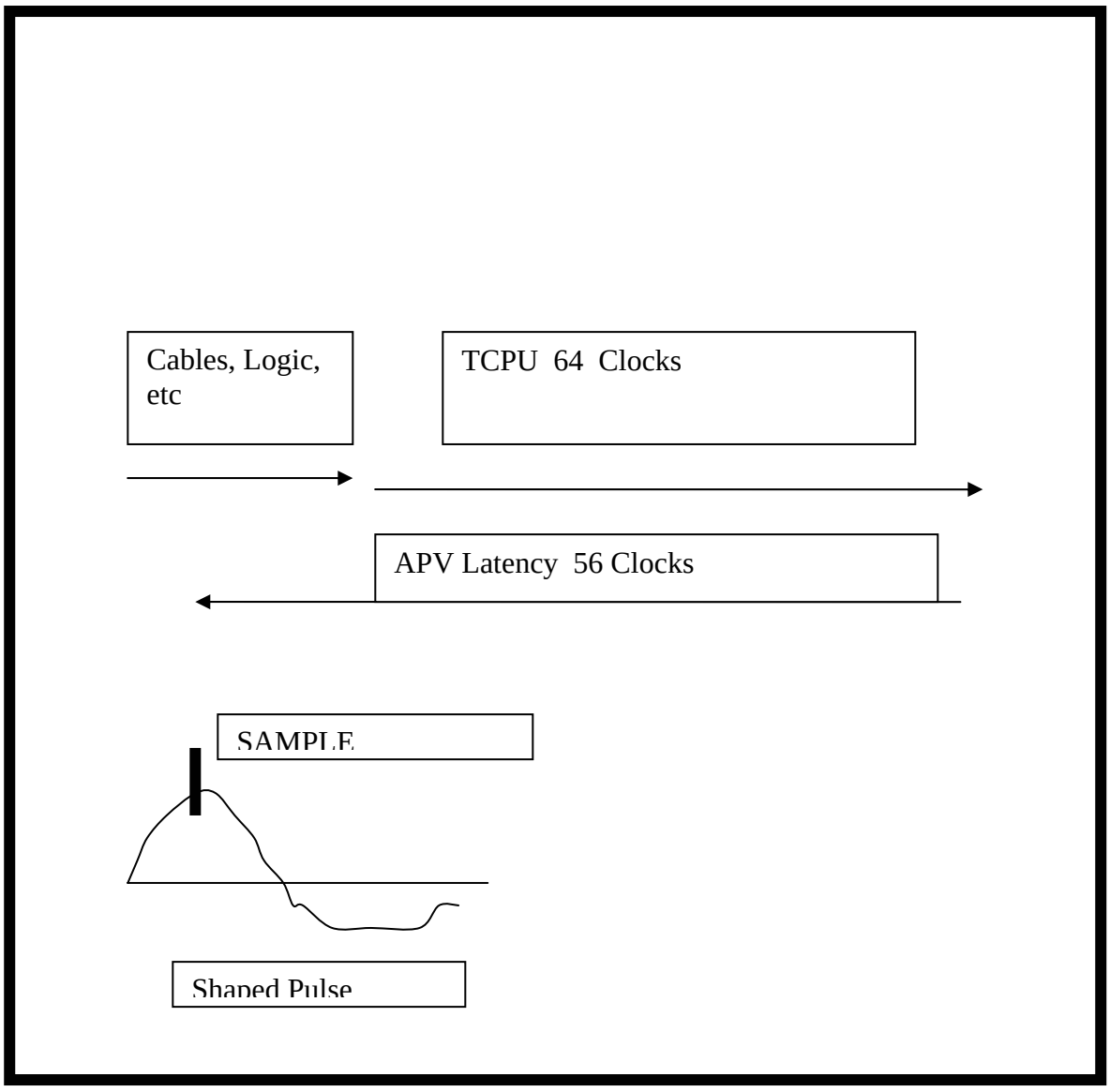
7) There are grounding and shielding problems. The digital ground on the GEM controller is 0.5 volts away from the other power and HV grounds. We should think about whether it is necessary to use APV signal return ground or the Digital ground which should have been real ground 1.25 V away from APV signal return.

Note on RPC vs GEM operation: The GEM readout strips were made to collect electrons directly after amplification. The RPC signals are inductively coupled from a dipole charge distribution in the gas gap between two sheets of insulating glass.

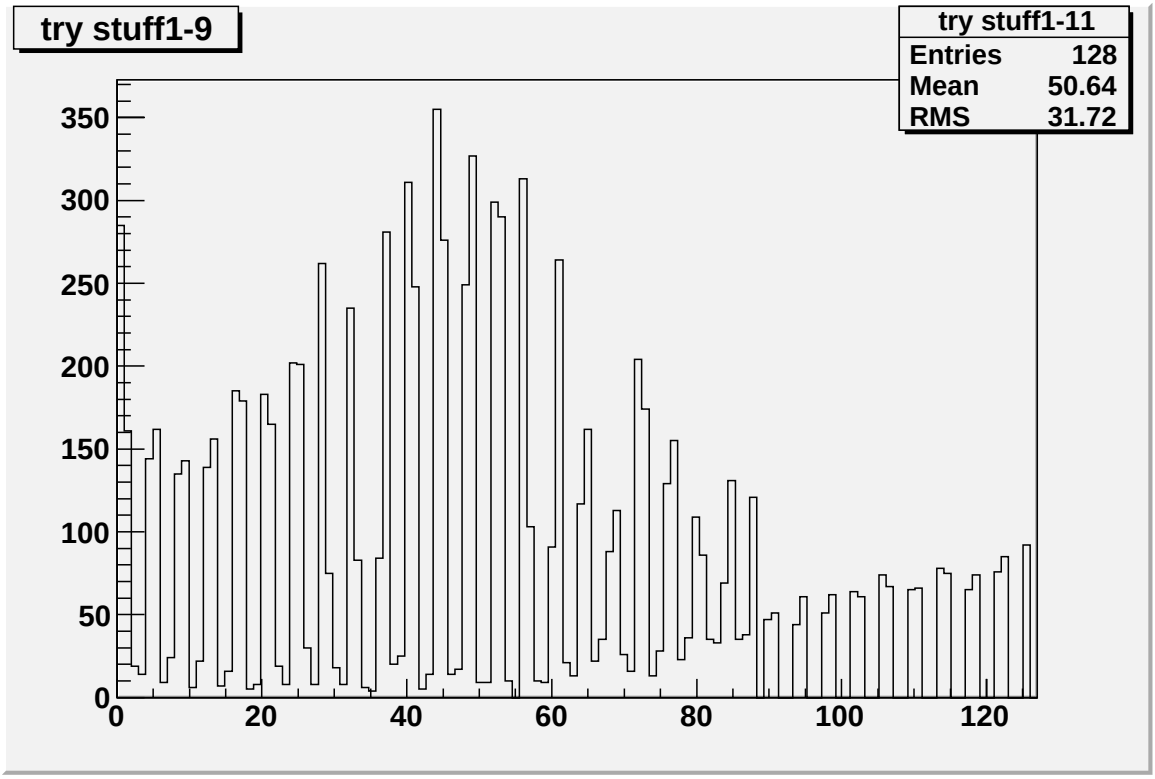
Technical Note: The STAR TCD introduces 110 ns jitter into the TCPU after a cosmic trigger because the cosmics are random with respect to the 9.1 MHz clock (like RHIC clock). We have a second signal path from cosmic ray logic into the TCPU and logic to use this to take out most of this jitter and reduce it to 25 ns. The APV is clocked to take a sample every 25 ns, so we can get within +- a clock time.


APV25
0
R
L
GEM READOUT STRIPS
X and Y OVER RPC
APV25
1
R
L
TOP
Trig.
Scintillator
MISSING
400 micron spacing
MISSING
R
L
R
L
APV25
2
APV25
3

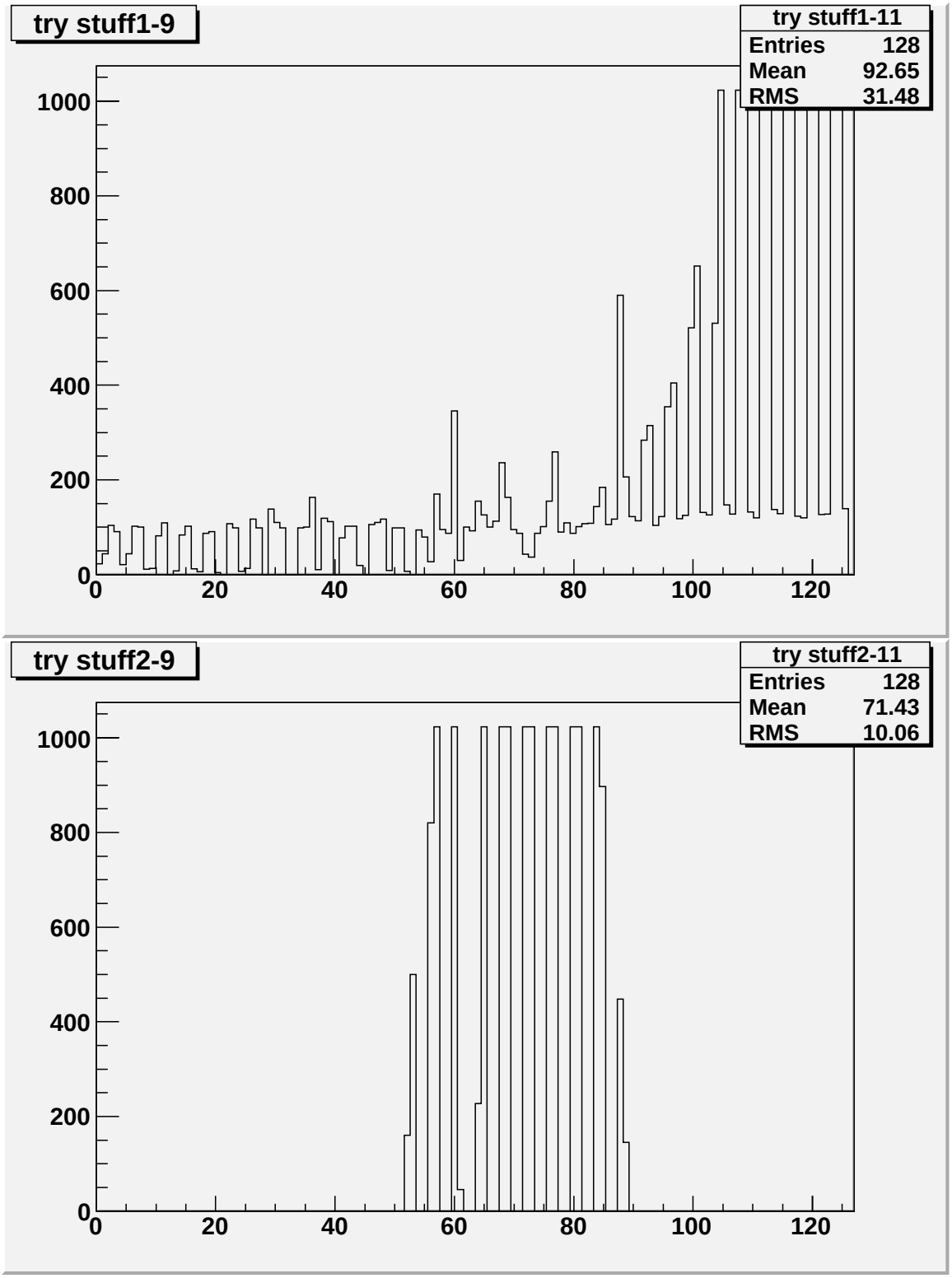

COSMIC
SCINT. top
APV25 #1
MISSING
APV25 #2
APV25 #3
GEM READOUT STRIPS (X-Y)
Resistive Plate Chamber
SCINT. bottom



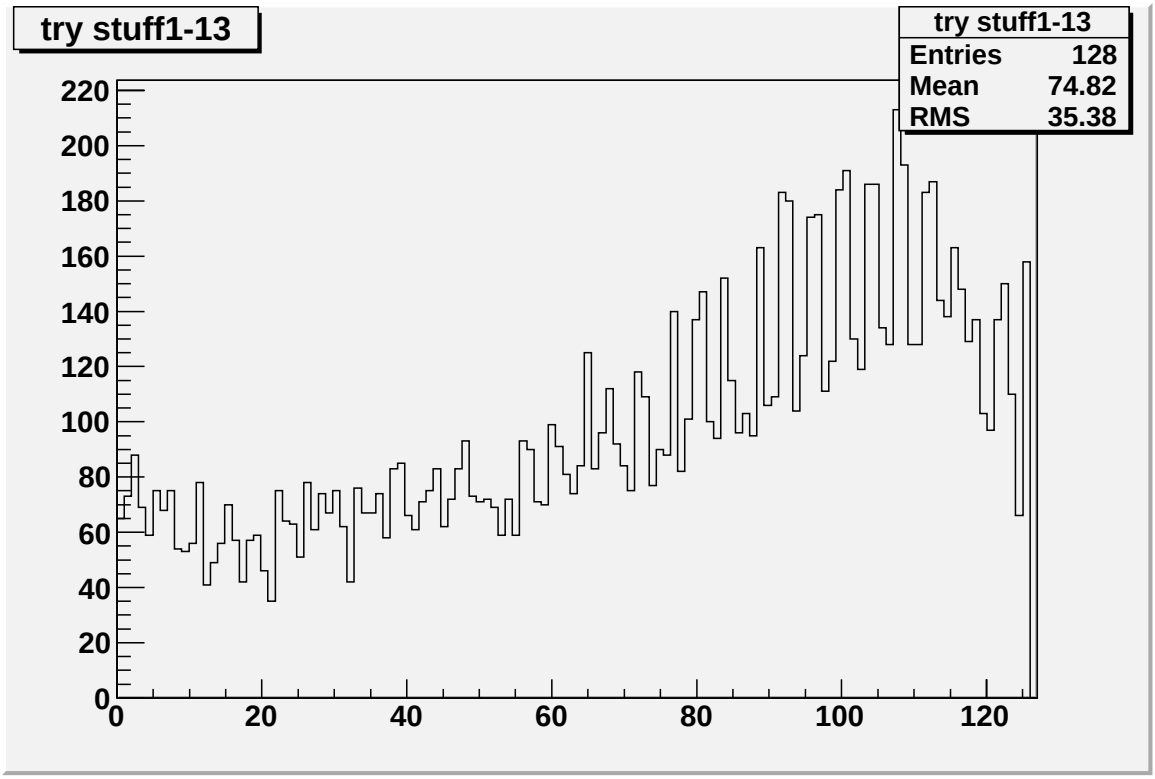
Times
Cosmic passes through scint and RPC
Analog Rotating buffer in APV25 samples continuously every 25 ns (before and after)
Delays in PMT, LOGIC, RG58 Cables, STAR TCD in VME, Flat Cable
Delay in TCPU 64 clocks (after special Diff ECL Cosmic cable)
Go backwards in time in APV25 by Latency number of clocks (hex 38 = dec 56)



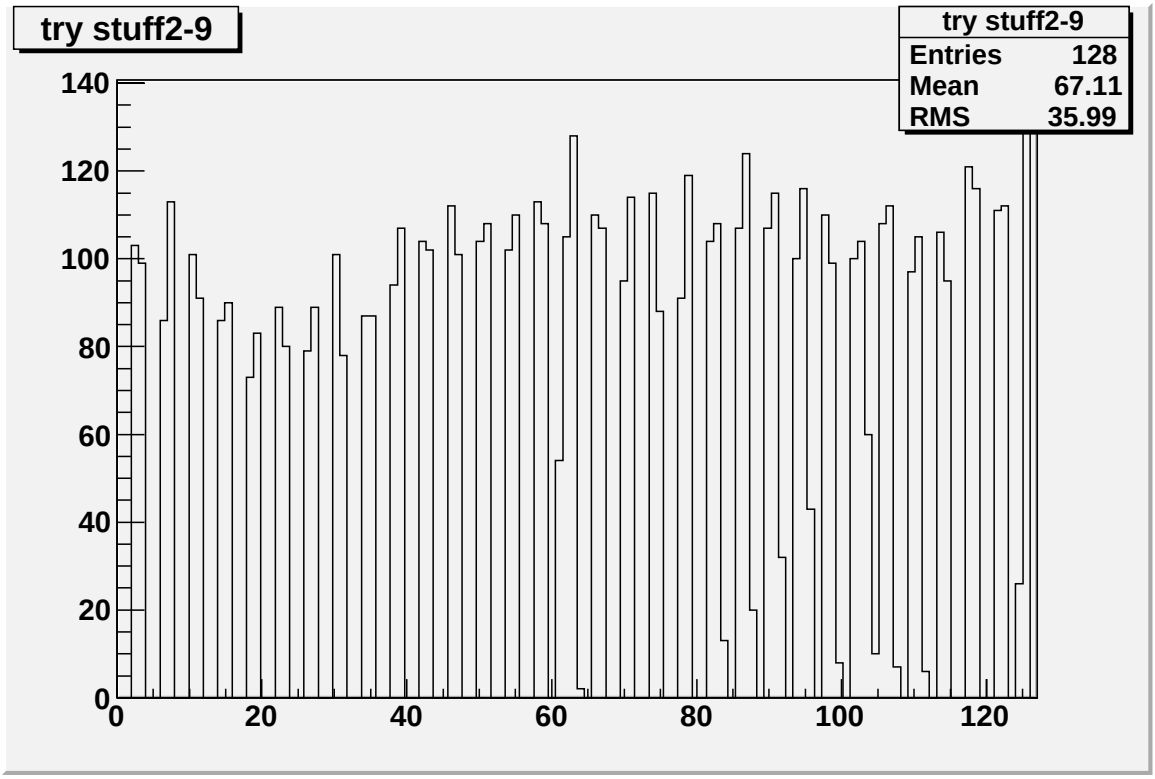
An event in chip 1 oct11_76_



Two views, X and Y, of the same event. Oct_11_76_40_9_1 and Oct_11_76_40_9_2.



Typical pedestal in APV chip 1 oct11_76_



Typical pedestal in APV chip 2 oct11_76_36_